



Agriculture and
AgriFood Canada

Agriculture et
Agroalimentaire Canada

Canada



MARKET OUTLOOK REPORT

Volume 6 Number 1

Canadian Farm Fuel and Fertilizer: Prices and Expenses

July 2015

MARKET OUTLOOK REPORT

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Electronic version available at
www.agr.gc.ca/pand-dco

ISSN 1920-082X
AAFC No. 12430E

The *MARKET OUTLOOK REPORT* series are published by the
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Paru également en français sous le titre :
RAPPORT SUR LES PERSPECTIVES DU MARCHÉ
Volume 6 numéro 1
Canada : achats de carburant et d'engrais dans les exploitations agricoles
ISSN 1920-0838
N° d'AAC 12430F

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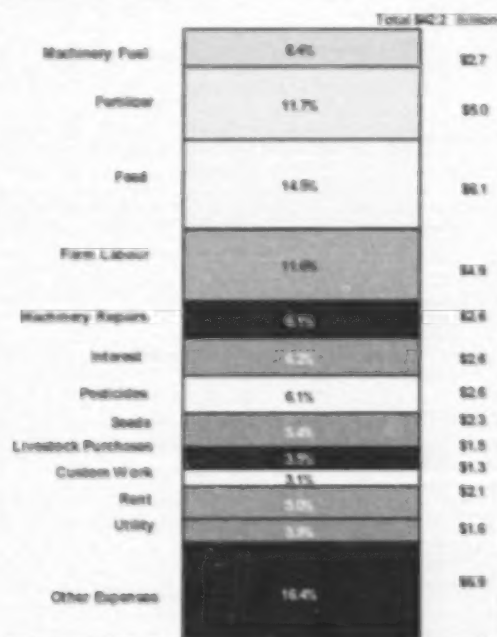
CANADIAN FARM FUEL AND FERTILIZER: PRICES AND FARM EXPENSES

This issue of the Market Outlook Report examines the situation and outlook for farm fuel and fertilizer prices and expenses in Canada for 2013 and 2014. Expenditures for fuel and fertilizers represented about 18% of farm operating expenses in Canada in 2013. Prices of fuel for farm machinery increased in 2013 and were higher for the year overall in 2014. Fertilizer prices decreased in 2013 and remained stable in 2014.

SUMMARY

Production and profitability in the primary agriculture is highly dependent upon fuel and fertilizer. Figure 1 shows the components of 2013 Canadian farm operating expenses. Fuel and fertilizer costs accounted for 18% of total Canadian farm expenses, or \$7.7 billion (bln). For every one cent per litre increase in fuel prices, Canadian farmers' annual machinery fuel bill increases by about \$27 million (mln). For fertilizer, every ten dollar per tonne increase in the price adds about \$68 mln to Canadian farmers' annual fertilizer bill.

Figure 1 _ CANADA: FARM OPERATING EXPENSES, 2013



Notes: (1) Rent includes cash rent and share rent. (2) Utility includes electricity, telephone and heating oil. (3) Other expenses include taxes, repairs to building and fences, irrigation, twine & wire, crop insurance premiums, ag & vet, business insurance, stabilization premiums, legal and accounting fee and other expenses.
Sources: (1) Statistics Canada; (2) AAFC calculations.

Fuel prices increased by 123% between 2003 and 2008, but the global recession led demand for energy to weaken and fuel prices to fall in 2009. However, fuel prices started to rise again in 2010 and this trend continued between 2011 and 2013 because of growing energy demand in emerging economies and slowing growth in supply. Fuel prices continued to rise for most of the year in 2014 as a result of geopolitical tensions in the major oil exporting regions.

Natural gas supplies have become more plentiful in North America as a result of advances in horizontal drilling and hydraulic fracturing technologies (fracking) for extracting shale gas. This kept US and Canadian gas prices depressed in 2011-2012. In 2013, natural gas prices rebounded somewhat in both the US and Canada, driven by increasing demand and declining production, but prices still remained below 2011 levels. Prices continued to increase in 2014.

Fertilizer prices in Canada began rising steadily in 2003, but increased sharply to reach an historical high in 2008. These increases abruptly halted in 2009 as a result of falling commodity prices, restricted availability of credit, and a sudden fall in energy prices, the result of a global financial crisis. Fertilizer prices resumed their climb in 2011 and continued to increase in 2012. However, prices decreased in 2013 in response to stagnant global fertilizer demand and oversupply in the global markets. Prices were projected to remain stable in 2014.

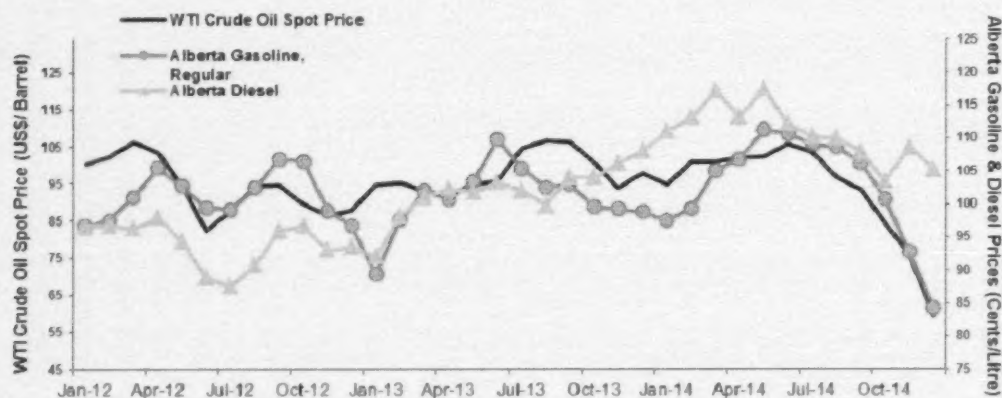
SECTION 1 - FARM MACHINERY FUEL

The Canadian agricultural sector relies heavily on petroleum to meet a variety of energy needs. Farm machinery fuel expenses consist mainly of diesel and gasoline, but also include lubricants. The price of fuel is generally determined by the forces of global supply and demand, and the agricultural sector is largely a price taker for both diesel and gasoline.

FUEL PRICES

Canadian fuel prices closely follow US energy prices. Figure 2 shows the actual energy price pattern in the US and Canada over 2012-2014. The West Texas Intermediate (WTI) crude oil price averaged about US\$98 per barrel in 2013, 4% higher than in 2012¹. Agriculture and Agri-Food Canada (AAFC) estimates that the prices paid by Canadian farmers for farm machinery fuel increased by 2.6% in 2013 over 2012.

Figure 2_ ENERGY PRICES IN ALBERTA AND UNITED STATES



¹ Source: the US Energy Information Administration (EIA).

Sources: (1) Alberta Agricultural Input Monitoring System (AIMS), Alberta Agriculture and Food, Economics and Competitiveness Division, Statistics and Data Development Unit; (2) United States Energy Information Administration (EIA); (3) Forecast from EIA and AAFC.

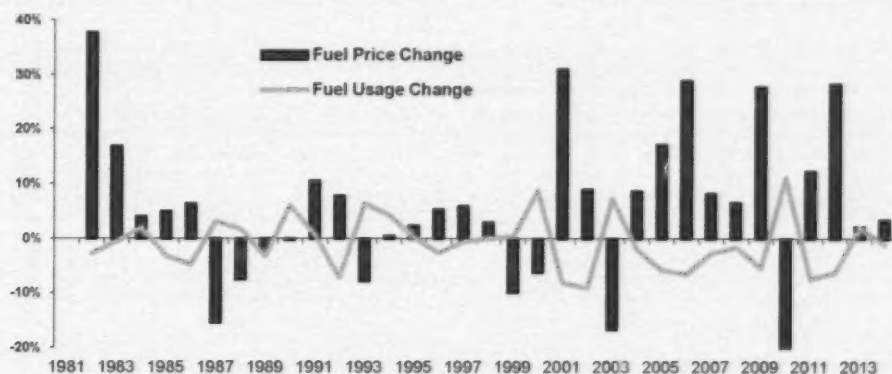
Fuel prices continued to increase for most of the year in 2014. However, crude oil prices started to drop significantly in October as Saudi Arabia was no longer willing to cut its oil production to support higher prices. At the same time, global demand growth slowed and a US shale oil boom increased the supply. In spite of the dramatic decline in the crude oil price during the third quarter of 2014, the drop in gasoline price didn't carry over to diesel due mainly to stronger heating fuel demand in the winter and the use of expensive additives in diesel for cold weather conditions that are not related to crude oil price. The US Energy Information Administration (EIA) estimated the price for WTI crude oil to average US\$93 per barrel in 2014, down 4.8% from the 2013 average.

Based on information available up to November 2014, AAFC expected that fuel prices for farm machinery in Canada would increase by about 4.8% in 2014 compared to 2013. This would translate into a \$127M increase in Canadian farmers' machinery fuel bill for 2014.

FARM FUEL USAGE

Price elasticity of demand measures the percentage change in quantity demanded resulting from a percentage change in price. Using 33 years of historical data from Statistics Canada, the price elasticity of demand for farm fuel in Canada is estimated at -0.25. This means that, on average, when fuel prices rise 10% Canadian farmers reduce fuel usage by 2.5%. Farmers' demand for fuel is relatively insensitive to price changes in the short-term because fuel is a necessity for farming and there are no immediate substitutes. Figure 3 illustrates the inverse relationship between fuel price and fuel usage over 1981-2013.

Figure 3 _CANADA: FARM MACHINERY FUEL PRICE AND USAGE CHANGE FROM PREVIOUS YEAR



Sources: (1) Statistics Canada and AAFC; (2) AAFC calculations.

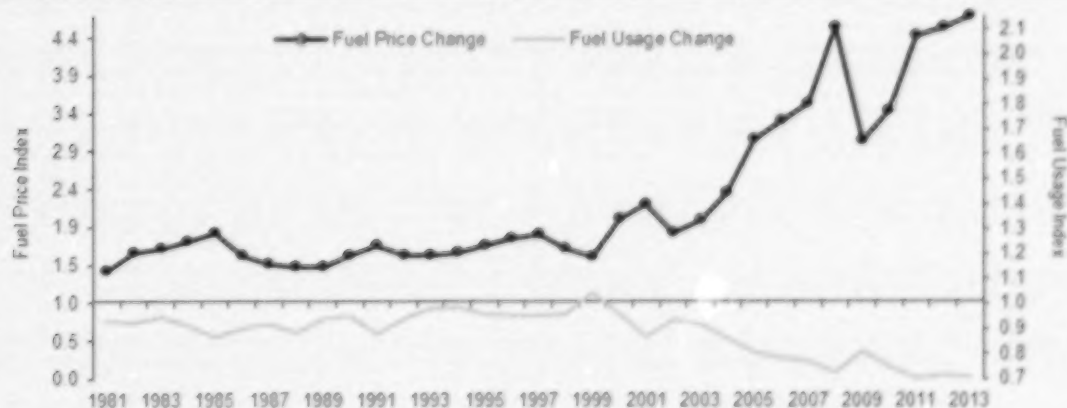
Figure 4 indicates that before 2000, farmers' long-term fuel usage was actually quite steady, averaging a 0.5% annual growth rate, with no significant variability in fuel prices. However, the volume of fuel used by farmers decreased by an average of 2.5% annually following a string of nearly continuous hikes in fuel prices over 2000-2013. Therefore, although higher fuel prices may reduce farmers' fuel usage in any given year, the price increase would have to persist for a longer period of time in order to reduce the fuel consumption trend.

In response to higher fuel prices, farmers have begun to factor in fuel efficiency into their machinery purchase decisions and have also altered their production practices. For example, they have adopted conservation tillage

practices such as no-till or minimum tillage that save fuel as well as provide other economic and environmental benefits.

Given the estimated elasticity and other factors such as seeded and harvested area, Canadian farm machinery fuel usage decreased by 1% in 2013. AAFC estimated Canadian farm machinery fuel usage was flat in 2014.

Figure 4_ CANADA: LONG-TERM TRENDS IN FARM MACHINERY FUEL PRICE AND USAGE
(BASE YEAR=1980)



Sources: (1) Statistics Canada and AAFC; (2) AAFC calculations

FARM FUEL EXPENSES

Given changes in both the price and quantity of farm fuels, Canadian farm machinery fuel expenses were \$2.7 bln in 2013, an increase of 2% over 2012, and above the 2008-2012 average of \$2.4 bln. Total expenses for farm machinery fuel were forecast to increase by 4% to \$2.8 bln in 2014.

SECTION 2 - FARM FERTILIZERS

Canada is one of the world's major producers of fertilizers, particularly nitrogen and potash. Production is located primarily in Alberta and Saskatchewan. In 2013, Canada exported about 67% of its potash production and more than a quarter of its nitrogen production, mainly to the US.

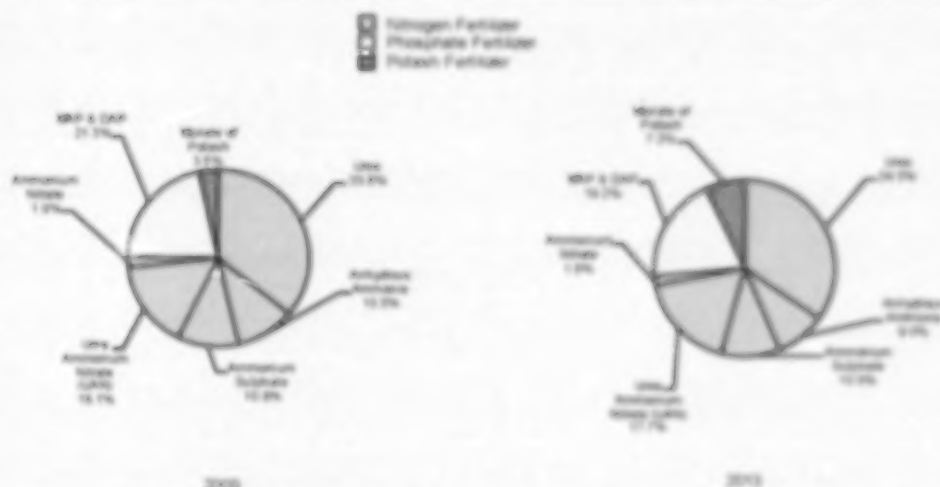
FERTILIZER TYPES IN CANADA

Fertilizers contain one or more of three key nutrients: nitrogen, phosphate and potassium. The nitrogen fertilizers that are currently used in Canadian agriculture are primarily anhydrous ammonia, urea, nitrogen solution, ammonium nitrate and ammonium sulphate. The phosphate fertilizers are monoammonium phosphate (MAP) and diammonium phosphate (DAP), both produced from phosphate rock. The other major nutrient used in crop production is potash fertilizer, which is important in soybean and corn production. The majority of potash production in North America takes place in Saskatchewan.

Figure 5 shows the usage of the major types of fertilizers used in Canadian agriculture in 2009 and 2013. Because of nitrogen's importance to plant growth and development, nitrogen is the most common nutrient used in agricultural production, accounting for 74% of total fertilizer usage, or about 5 million tonnes in 2013. The usage of nitrogen increased at an annual growth rate of 4.8% from 2009 to 2013, with urea representing the largest

volume used. Phosphate fertilizers accounted for 19% of total fertilizer usage, or about 1.3 million tonnes in 2013. Potash fertilizer accounted for 7% of total usage, or about 0.5 million tonnes in 2013.

Figure 5. CANADA: FERTILIZER TYPES AND USAGE, 2009 AND 2013



Sources: (1) Statistics Canada, (2) AAFC calculations

DETERMINATION OF FERTILIZER PRICES

The traditional factors for determining fertilizer prices are production costs, market demand and competition. In addition, prices for all three types of fertilizers at the retail level are affected by prices for gasoline and diesel because transportation costs represent an important part of the cost of marketing fertilizer. Other factors, such as exchange rates and government policies, also have an effect on fertilizer pricing.

Production Costs

The factors affecting the cost of production are different for each type of fertilizer. The following section will discuss each of the cases for nitrogen, phosphate and potash fertilizers, respectively.

(1) Natural Gas Prices

Anhydrous ammonia is the primary component of nearly all nitrogen fertilizers produced in the world. Ingredients for the production of anhydrous ammonia are air, steam and natural gas, with the latter accounting for 70-80% of the production cost of ammonia. Therefore, natural gas prices are one of the key determinants of nitrogen fertilizer prices.

Figure 6 shows natural gas prices in comparison with crude oil prices in Alberta and the US over 1995-2013. In the past, natural gas and crude oil prices were highly correlated, so that changes in the price of oil translated into changes in the price of natural gas. However, the massive gas supply that has resulted from the proliferation of shale gas wells has kept US and Canadian natural gas prices low in recent years, causing natural gas and crude oil prices to decouple from one another after 2010. Though natural gas prices rebounded somewhat in 2013, they still remained below the 2011 levels. The US natural gas Henry Hub spot price averaged US\$3.84 per thousand

could feel in 2013, 38% higher than in 2012.¹ Similarly, AAFC estimates that the natural gas price in Alberta increased by 33% in 2013. The US Energy Information Administration (EIA) projected that natural gas prices could continue to increase in 2014.

Figure 8. NATURAL GAS AND CRUDE OIL PRICES IN ALBERTA AND THE UNITED STATES, 1999-2013



Sources: (1) Alberta Agricultural Input Monitoring System (AAIMS), Alberta Agriculture and Food, Economics and Competitiveness Division, Statistics and Data Development Unit; (2) United States Energy Information Administration.

It is important to examine whether the plunging natural gas price has led to lower nitrogen prices in recent years. The ammonia-to-gas monthly price change ratio² measures whether or not nitrogen fertilizer prices track natural gas prices. A ratio equal to 1 means that nitrogen prices track natural gas prices. A ratio above 1 indicates that nitrogen prices change at a greater pace than natural gas prices, while a ratio below 1 indicates the reverse. Figure 7 illustrates that the ratios were mostly within ± 0.04 of 1 over 1991 to 2008, meaning that the nitrogen fertilizer price generally tracked natural gas price closely for that period. However, the two prices series appear to have disconnected from one another after 2008 with most of the ratios swinging away from 1.

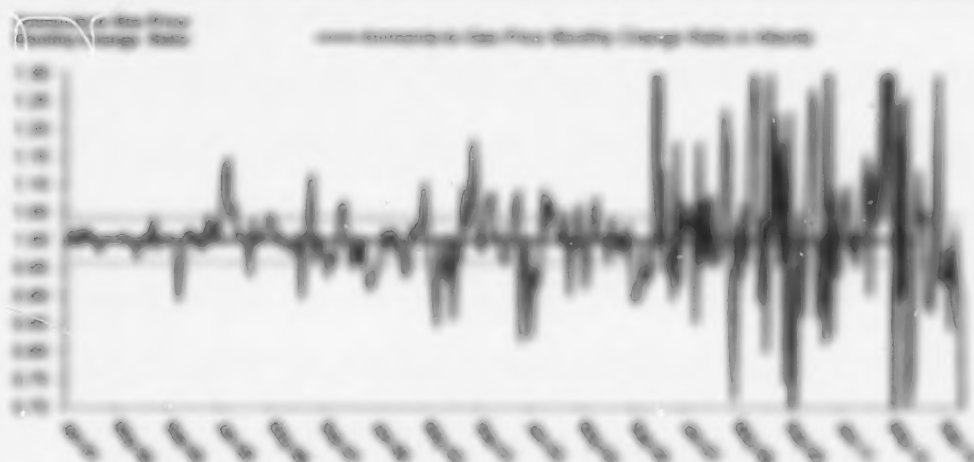
The correlation coefficient is another indicator that is used to measure the degree to which two variables are associated, with values close to ± 1 indicating that the two variables are highly related. The estimated correlation coefficients between natural gas prices and fertilizer prices confirm the previous finding, with an estimated correlation coefficient of 0.81 over 1991-2008, but only 0.13 over 2007-2013. Therefore, natural gas prices appear to have had less impact on fertilizer prices in recent years than they used to.

Like natural gas prices, abundant natural gas supplies, and solid nitrogen prices have led to investment in new fertilizer capacity including the construction of new plants, restarting closed plants and possible expansion of existing facilities. This will likely put downward pressure on fertilizer prices when these projects come on stream. However, there also may be a host of obstacles, such as environmental issues and long-term financial costs that could make construction of new sites unattractive.

¹ Based on information from the US Energy Information Administration (EIA) as of August 2014.

² Computed by dividing the monthly change in ammonia price by the monthly change in natural gas price.

Figure 7. AMMONIA TO GAS PRICE MONTHLY CHANGE RATIO IN ALBERTA, 1991-2012



Source: (1) Alberta Agriculture and Forestry (Alberta AgStats), Alberta Agriculture and Forestry, Economics and Comprehensives Section, Statistics and Data Development Unit; (2) AEP's calculations.

2. Cost

China is the largest consumer and also a significant exporter of fertilizers (until the end of 2007, the primary bottleneck for producing ammonia there is a lack instead of natural gas, which affects Chinese ammonia endowments: only 1% of the world's proven natural gas reserves, but 16% of the world's endowment). The Chinese government in the past had an export subsidy to encourage the fertilizer industry to increase its production capacity. However, the government canceled the fertilizer export subsidy after 2005 and opened its export up to the world market to ensure an adequate supply for its domestic needs. Nevertheless, the export has not been large during the off season.¹ The role of China as a major importer of urea and phosphate fertilizers has been increasing in recent years, making China one of the most prominent players in determining prices globally. Figure 1 shows that the structure of the Chinese export left resulted in large swings in volumes and therefore great volatility in global fertilizer prices between the low-off season and the high-off season. As China has the cost advantage compared fertilizer producers, any shifts in the Chinese supply/demand balance resulted in a major impact on global markets.

2.1 Ammonia, Phosphate Rock and Sulfur Prices

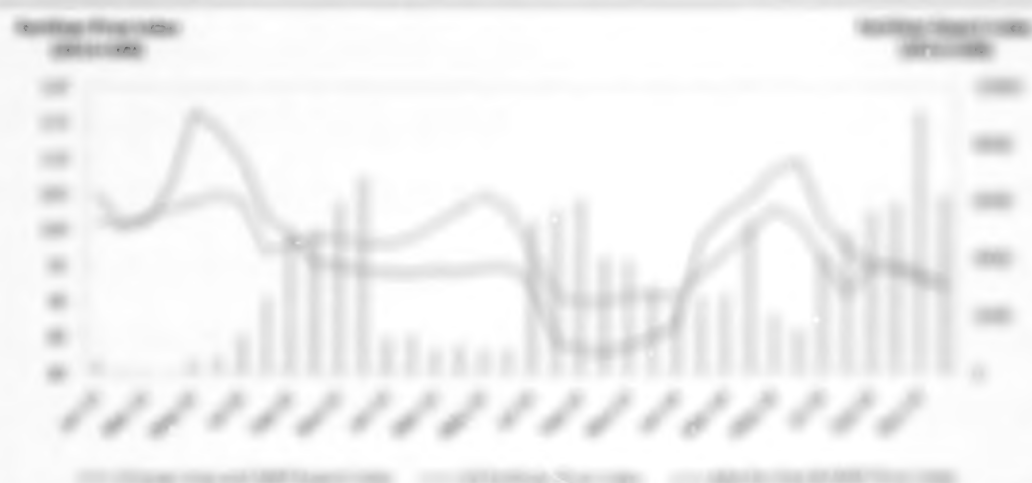
Ingredients to the production of phosphate fertilizers, NH_3 and DAP are ammonia, phosphate rock and sulfur. Figure 1 shows how increased ammonia, phosphate rock and sulfur prices had profound implications on phosphate fertilizer prices over the period 2002-2012. Although prices of ammonia, phosphate rock and sulfur generally remained flat with no significant volatility until 2005, markets began to tighten in 2007, with prices of these raw materials reaching a peak in 2008. The dramatic increase in raw material prices significantly drove up phosphate fertilizer prices during 2007 and 2008. However, the situation reversed itself in 2009 and 2010.

¹ Though Sustainable Use of Nitrogen Fertilizers in China, National Foundation of Agricultural Economics, University of California.

For urea, July 1 to October 31 has been the off season since 2011. For phosphate, June 1 to September 30 was the off season before 2012, while May 1 to October 31 has been the off season since 2012.

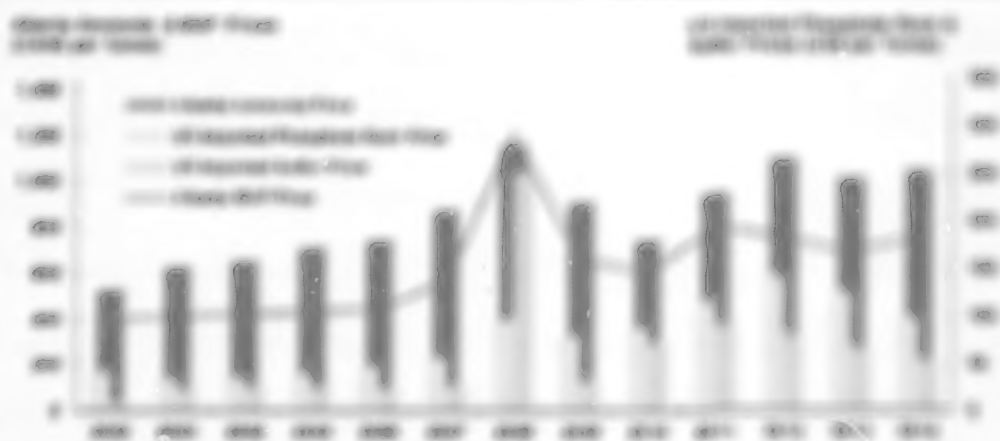
country's long-term growth prospects. The 2015 survey also noted a number of other challenges facing the country.

Figure 5. Domestic Supply and Demand for Wheat and Wheat Products, 2005-2015 (MT/1000)



Domestic (1) Domestic Supply (MT/1000), (2) Domestic Demand (MT/1000), (3) Domestic Supply (MT/1000), (4) Domestic Demand (MT/1000), (5) Domestic Supply (MT/1000), (6) Domestic Demand (MT/1000). Domestic Supply and Demand (MT/1000) are shown as solid lines. Domestic Demand (MT/1000) is shown as dashed lines. Domestic Supply (MT/1000) is shown as solid lines. Domestic Demand (MT/1000) is shown as dashed lines.

Figure 6. Wheat Production, Imports and Exports (MT/1000)



Domestic (1) Wheat Production (MT/1000), (2) Wheat Imports (MT/1000), (3) Wheat Exports (MT/1000), (4) Wheat Imports (MT/1000), (5) Wheat Exports (MT/1000). Wheat Production (MT/1000) is shown as solid lines. Wheat Imports (MT/1000) is shown as solid lines. Wheat Exports (MT/1000) is shown as solid lines. Wheat Imports (MT/1000) is shown as solid lines. Wheat Exports (MT/1000) is shown as solid lines.

Figure 10. Monthly Average Rainfall (mm) and Maximum Rainfall (mm)

The monthly average rainfall and maximum rainfall are shown in Figure 10. The monthly average rainfall is shown in the left y-axis, and the maximum rainfall is shown in the right y-axis. The monthly average rainfall is shown in the left y-axis, and the maximum rainfall is shown in the right y-axis.

Figure 11. Monthly Average Rainfall (mm) and Maximum Rainfall (mm)

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Figure 1. Comparison of simulated and observed water quality data for the period 1990-2000.



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The results of the simulation are presented in Figure 1. The figure shows the comparison of simulated and observed water quality data for the period 1990-2000. The figure consists of two bar charts. The left chart is titled 'Observed Data' and the right chart is titled 'Simulated Data'. Both charts show water quality data for 11 different locations (1-11) on the x-axis. The y-axis represents a water quality parameter ranging from 0 to 100. The legend indicates three data series: Observed (black bars), Simulated (white bars), and Error (grey bars). In the 'Observed Data' chart, the black bars are generally higher than the white bars, with a significant peak at location 10. In the 'Simulated Data' chart, the white bars are generally higher than the black bars, with a significant peak at location 10. The error bars are relatively small, indicating a good fit between the simulated and observed data.

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Discussion

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Figure 1. The time series of the monthly mean precipitation (mm) over the period 1979-2000. The data are obtained from the National Centers for Environmental Prediction (NCEP) reanalysis. The figure shows a clear seasonal cycle with a maximum in the summer months and a minimum in the winter months. The overall trend is relatively flat, indicating no significant long-term change in precipitation over the period shown.



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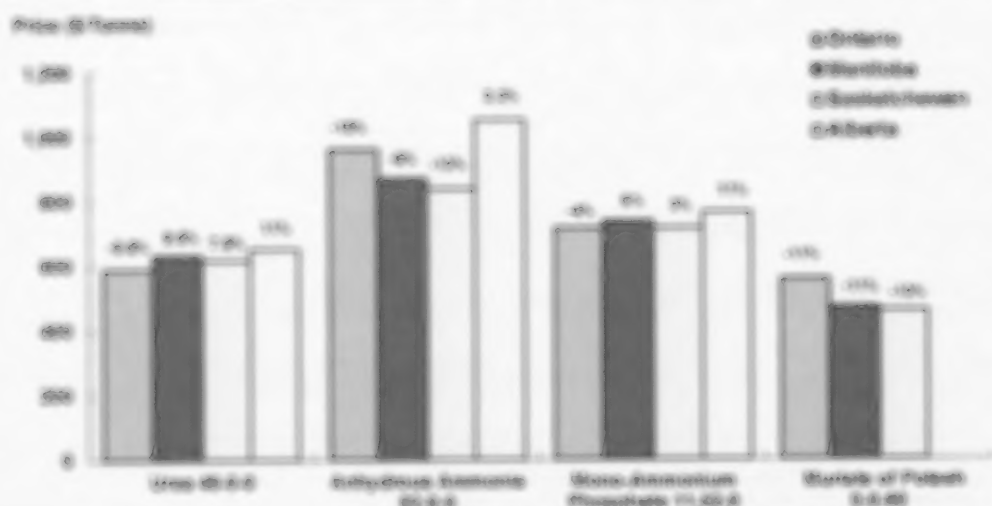
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APPENDIX B: DATA SOURCES

The data used in this study were obtained from the National Centers for Environmental Prediction (NCEP) reanalysis. The data are available at the National Centers for Environmental Prediction (NCEP) website.

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Figure 13. FERTILIZER PRICES IN 2014 AND THEIR PERCENTAGE CHANGES FROM 2013 IN ONTARIO, MANITOBA, SASKATCHEWAN AND ALBERTA



Sources: (1) AgFC Farm Input Price Survey; (2) Alberta Agricultural Input Monitoring System (AIMS), Alberta Agriculture and Food, Economics and Competitiveness Division, Statistics and Data Development Unit; (3) AgFC calculations.

FARM FERTILIZER USAGE

Using 1981-2012 annual historical data, the elasticity of fertilizer consumption with respect to the seeded area of major grain and oilseeds was estimated to be 0.88 in Canada. In other words, on average, a 1% increase in seeded area resulted in a 0.88% increase in fertilizer use. Given seeded area and other factors, Canadian fertilizer usage was estimated to be higher in 2013 compared to last year. AgFC estimated Canadian fertilizer usage would remain flat in 2014.

FARM FERTILIZER EXPENSES

Farm fertilizer expenses include all costs associated with the purchase of fertilizer and lime, including application costs if they are included in the price paid by a farmer. In Canada, when price and usage changes were considered together, fertilizer expenses were estimated to have reached \$4.55/bt in 2013, a decline of 6% over 2012, but still greater than the 2008-2012 average annual expense of \$4.2/bt. Fertilizer expenses in 2014 were forecast to be flat compared to 2013.